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Influence of Target Geometry on Maximum Electric Field in Plasma Immersion Ion Implantation.
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Plasma immersion ion implantation (PIII) is an effective surface modification technique. In PIII, a bias voltage is applied to the target to accelerate ions from the surrounding plasma into the target. The electrical field thus depends very much on the applied voltage, plasma density, target shape, and other instrumental factors. There is also a maximum electric field to avoid arcing. For pressure lower than 1 Pa, this field strength is on the order of 10 kV/mm. In PIII, processes, this limiting field strength occurs at the beginning of each voltage pulse because the field decrease as the plasma sheath expands. In the inversion of three-dimensional samples, the field is enhanced at edges in protrusions and the extent depends on the shape and relative dimensions. In this work, we simulate the electrical field around a thumb-shaped target using the two-dimensional Poisson's equation. The target geometry is varied from 90 to 150 degrees to demonstrate the effect of the edge angle on the electrical field. We also discuss the influence of the target size, plasma density, and applied voltage on the electrical field.

Control of Implantation Area in Direct-Current Plasma Immersion Ion Implantation (DC-PIII)
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In plasma immersion ion implantation of planar samples such as silicon wafers, the only important ions are the ones arriving at the top surface. This is true for PIII - Ion CIV as well as SPMOX (separation by plasma immersion of oxygen). In fact, ions implanted into the other surfaces are undesirable as they reduce the efficiency of the power supply and plasma source as well as give rise to metallic contamination. We have demonstrated direct-current plasma immersion ion implantation (DC-PIII) by using a grounded grid to separate the vacuum chamber, and this technique is excellent for planar sample implantation. The advantages include lower equipment cost, higher power and time efficiency, larger impact energy, and last but not least, the ability to perform high-energy implantation in a small vacuum chamber. In this paper, we present our work on the control of the implantation area by adjusting the radius of the extraction hole, the distance between the conducting grid and the sample, and the radius of the water stage. The simulation is conducted using particle-in-cell (PIC) simulation and the results are checked by experiments. Our results indicate that the implanted area increases with the radius of the extraction hole and water stage, but decreases with larger distance between the grid and sample. The effects of the extraction hole radius are the largest, followed by the placement of the conducting grid. The wafer stage poses the least influence. According to our simulation and experimental results, there is an optimal range of ratios of these parameters for each wafer size.